LUBRICATION

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EDITORIAL

We print in this issue of Lubrication an article on the Specifications of Oil, to which we are drawing special attention in this editorial on account of the importance of the subject. Time after time we have been impressed with the fact of the inadequacy of buying oil under specifications. This has been made unusually clear to us after we have made examinations of the mechanical conditions at the plants involved. Time after time we have succeeded, after studying the mechanical conditions at the plants to be lubricated, in reducing the number of oils required, increasing the economy very considerably and generally improving the conditions of the plant by neglecting the matter of specifications altogether. Many specifications for oil have not been changed for the last ten years, and do not represent oils which are at present available and eminently suited for the conditions which were supposed to have been covered by the original specifications. Laboratory tests have very little practical bearing upon the subject of lubrication, and frequently the attempt to purchase oils upon the basis of these tests results in limiting possible competition without in any way increasing the value of the material which is purchased on this basis. In fact, in many cases the reverse is true, and the plants in question could secure very much better service by throwing the specifications into the discard and demanding oils which will meet the practical conditions of work. In a great many lines of industry it has been found necessary to change the method of buying in order to secure materials which represent the greatest value for the actual conditions of work, and in the oil business the entry into the market of crudes from many different sources, all having different characteristics, has placed at the buyer's hand a wide range of materials from which to draw for an oil suitable to his particular conditions. Outside of the fact that the specification habit was contracted years ago, there is no reason why the present day consumer should not take advantage of the present situation, and by asking his oil supplier to furnish him with the most suitable oil for certain mechanical conditions, thereby greatly benefit not only by a possible saving of money, but a possible saving of considerable frictional loss.

OIL GROOVES IN BEARINGS

By C. N. Scott, Consulting Engineer

Many theorists on lubrication maintain that oil grooves in a bearing are detrimental, in that they (1) reduce the bearing surface, and (2) offer a means of escape of the oil from between the two rubbing surfaces of the journal. Theoretically, these men are right, as far as they go, but they lose sight of the fact that means have to be provided (1) for getting the oil to and distributing it over all portions of the bearing surfaces, and (2) for retaining the oil in the journal; and it is these functions which oil grooves perform so successfully which make them indispensable.

We have seen many instances where the theory that oil grooves were unnecessary and detrimental was followed, and which resulted in continued trouble from heating of the bearings until the operating engineer took upon himself to provide oil grooves, after which no heating or kindred troubles were experienced.

There are many different arrangements of oil grooves in use; some of them are planned with due regard for what they are intended to accomplish; others are planned without any conception of what oil grooves are intended to do or how they are to do it; and others are not planned at all, but are as aimless as, and often resemble, worm tracks in soft mud.

Most manufacturers of engines and machinery design their product, giving little or no consideration to the matter of detail lubrication, leaving the placing of oil holes and the designing and locating of oil grooves entirely to the "judgment" of the shop foremen or of the erector who sets up the engine or machine in the shop, or of the individual fitters who assemble the different parts. In other words, oil holes and oil grooves are seldom shown on the drawings, but their design is generally left to men who, while they are good shop mechanics, yet know little or nothing of the operation and lubrication of such machinery. Is it any wonder, then, that bearing troubles are experienced and that operating engineers in many instances find it necessary to use much oil with less efficiency when, if oil grooves had been correctly designed, a proper amount of suitable oil would work better and at much less cost.

The functions which oil grooves are intended to perform are:

(a) To provide a receptacle for receiving the oil into the bearing.

(b) To distribute the oil lengthwise of the bearing, so that the moving surface passing the grooves or chamfers is bathed in and coated with oil.

(c) To distribute oil from the grooves and chamfers over the bearing surfaces.

(d) To catch oil which has squeezed over towards the ends of the bearing and thus prevent it from working out of the bearing entirely; and

(e) To return such oil to the center of the bearing, where the cycle of distributing, catching and returning it again to the center of the bearing is again started and repeated over and over.

In order to more fully explain these functions, we would refer you to sketch No. 1, which shows the grooving of the crank-pin boxes of a connecting rod of a large horizontal engine. Oil enters at A; drops or runs on to the crank-pin and accumulates at B; spreads in both directions along the chamfered edge B (which acts as a primary groove), and coats the surface of the pin, as well as surface C, with oil. Upon reaching the secondary grooves D,D the oil leaves the cham-

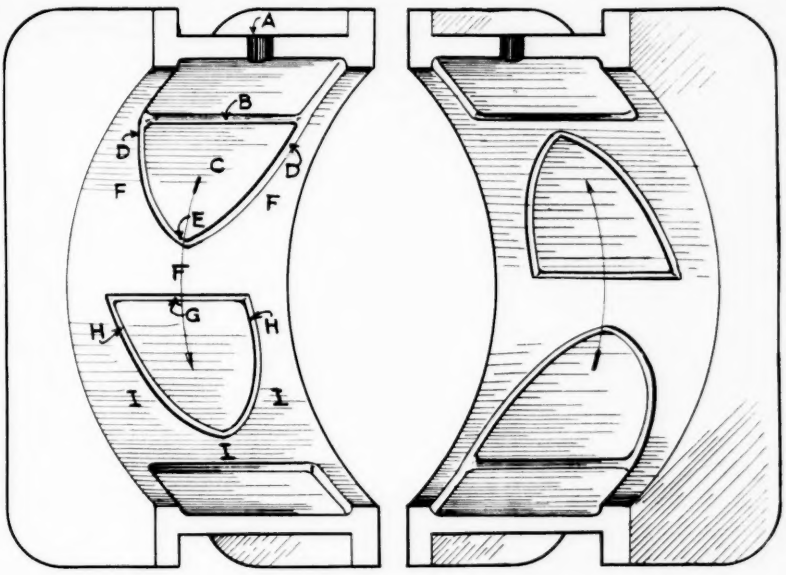


FIG. 1

Crank Pin Boxes of a Connecting Rod, Showing Oil Grooves.

fered edge and follows the secondary grooves back to the center of the bearing at E, being distributed from the secondary grooves over the surfaces F,F,F. From the surfaces F,F,F the oil works into the primary groove G, in which it is again spread in both directions to the secondary grooves H,H, being again returned in these to the center of the bearing, as before, and distributed over the surfaces I,I,I. These functions are repeated over and over.

In grooving bearings, it is of the greatest importance that the following general instructions be observed:

1.—Do not groove both the male and female surfaces of a bearing; grooving one surface is right; grooving both surfaces is wrong. The female or enveloping surface is the one which should be grooved; for example:

(a) The bearing surfaces of the connecting rod boxes are grooved, and not the surface of the crank-pin and cross-head pin.

(b) The bearing surfaces of the crank-shaft bearing shells or boxes are grooved, and not the bearing surfaces of the crank-shaft.

(c) The bearing surface of the eccentric strap is grooved, and not the bearing surface of the eccentric.

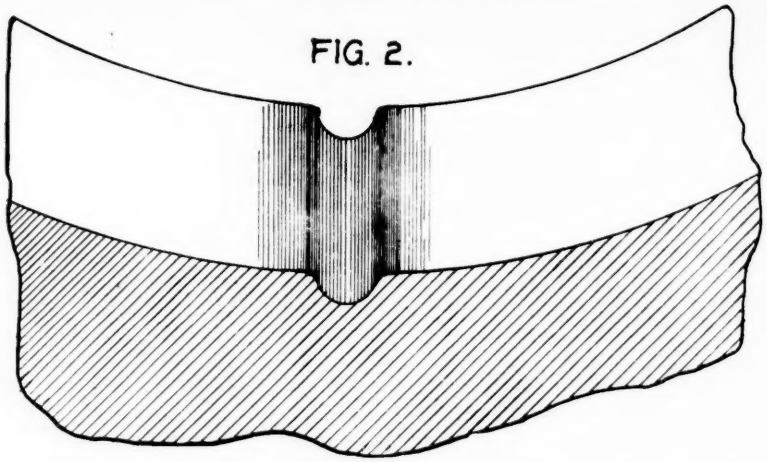
(d) The bearing surface of a pillow-block is grooved, and not the surface of the shafting.

(e) The bearing surface of the hole in a connection head is grooved, and not the surface of the pin.

There are a few exceptions to this rule, among them being:

(1) The bearing surfaces of the shoes of a cross-head, which are grooved, and not the bearing surfaces of the bored guides.

(2) The bearing surface of shafting or sleeves which work in long, solid bearings and which are



Section Thru Part of Bearing, Showing Rounding of Corners of Oil Groove.

grooved on account of the bearing being too small in diameter and too long to permit of internal grooving.

2.—Make the width and depth of the grooves good and liberal. It is customary to err in the direction of making them too narrow and too shallow, with the result that they clog up too readily. If a bearing which is equipped with shallow, narrow grooves heats slightly at any time, the grooves become plugged, lubrication ceases, and it is then necessary to shut the engine or machine down and dismantle the bearing in order that the deposit can be removed from the grooves.

It is difficult to fix any general rule for the dimensions of oil grooves, but the following one gives results which agree closely with the best practice:

For Width of Groove:

Multiply the diameter of shaft or pin in nearest even inches by .01 and add 1/10".

For Depth of Groove:

Take half of width.

Examples:

Grooves for a 30" crank-shaft bearing would be (30" x .01) + .1" = 4/10" wide and 2/10" deep, or say 3/8" wide by 3/16" deep.

Grooves for a 12" crank-pin box would be (12" x .01) + .1" = 22/100" wide and 11/100" deep, or, say 1/4" wide and 1/8" deep.

Grooves for a pin bearing 1-3/4" diameter would be (2" x .01) + .1" = 12/100" wide and 6/100" deep, or, say 1/8" wide and 1/16" deep.

Well designed bearings will have sufficient thickness of babbitt lining or bushing to safely accommodate the above depth of groove.

3.—Round all corners of grooves well, as shown in section in Figure 2. This is important, as it ensures the flowing or "wedging" of oil from the grooves into the space between the rubbing surfaces. An oil groove having sharp, square edges will scrape oil from the ungrooved surface of the journal instead of allowing a fine film of oil to squeeze from the oil groove into the space between the rubbing surfaces. This rounding of the edges of oil grooves is one of the most important factors in securing successful lubrication of a bearing and is the one which is in so many instances neg-

lected entirely. If an engineer desired to provide a number of sharp scrapers to remove the oil from the ungrooved surface of the journal, he could not do it more effectively than by the use of sharp-edged oil grooves.

4.—Be careful to arrange the oil grooves with particular reference to the direction of motion of the ungrooved surface on the grooved one. This is of the greatest importance, because it is this movement of one surface on the other which effects the movement of the oil in the bearing, and if a bearing is grooved for the wrong direction of motion the grooves will work the oil out of the bearing instead of towards the center of it. Gravity has little or no effect on the movement of oil in a journal.

5.—Do not extend the grooves too close to the edges of the bearing surfaces, as this would allow the oil to escape from the journal. As a general proposition, keep grooves away from edges of bearing surfaces from 3/4" to 1-1/2", depending on the size of the journal.

6.—Grooves and chamfers should be smooth and regular.

Figure 3 shows the oil grooving in the main crank-shaft bearing of a

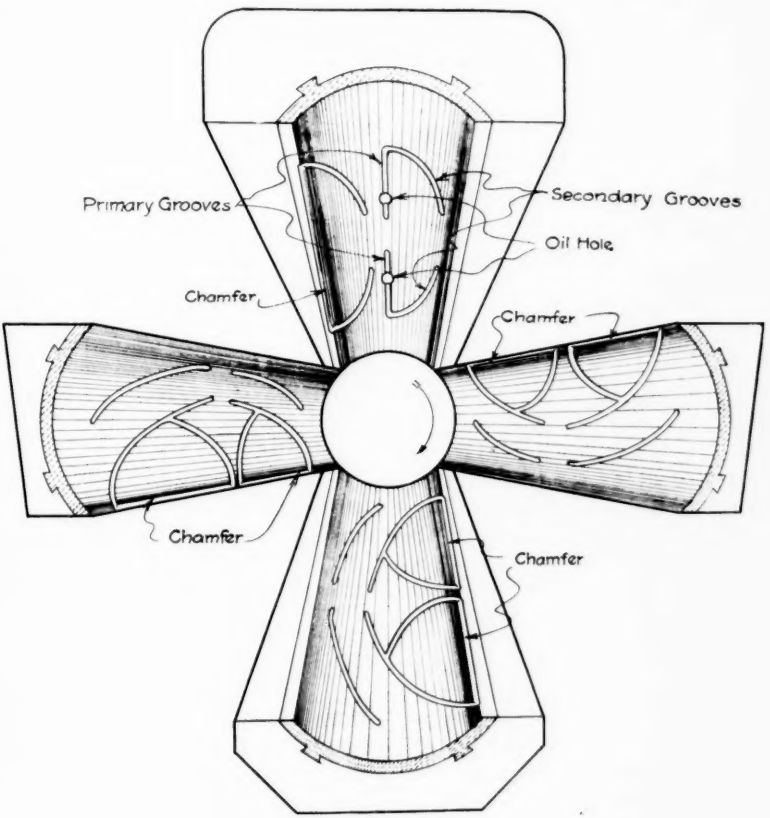


FIG. 3.

Crank Shaft Bearing for Horizontal Engine Showing Oil Grooves.

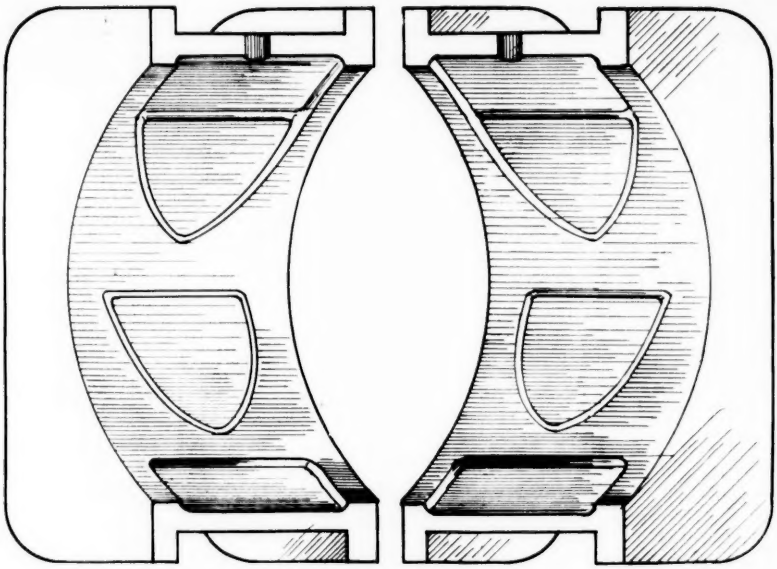


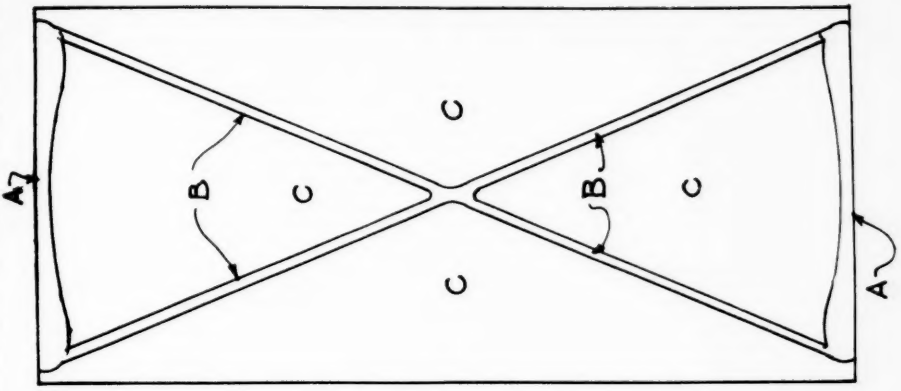
FIG. 4.
Cross Head Pin Boxes of a Connecting Rod, Showing Oil Grooves.

horizontal engine. This bearing is of the 4-part type, consisting of two side shells, one top shell and one bottom shell. This type of bearing is a difficult one to lubricate successfully and economically unless it is properly grooved. A study of these grooves will show how they effect the distributing, catching and returning of the oil to the center of the bearing.

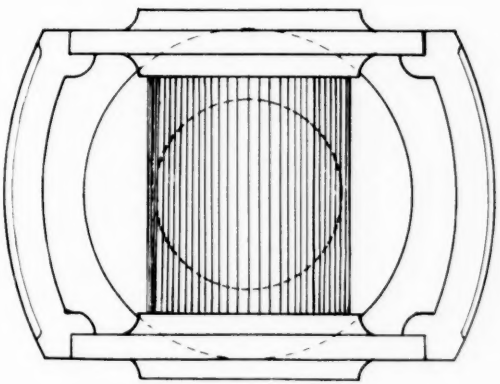
Figure 4 shows the oil grooving in the cross-head pin boxes of a connecting rod of a horizontal engine. It will be noted that while the grooves are similar in arrangement to those in the crank-pin boxes shown in Figure 1, they differ in this respect, that both halves of the box are grooved for surface wiping movement from the top down; this for the reason that the movement of the connecting rod boxes on the cross-head pin is an oscillating one.

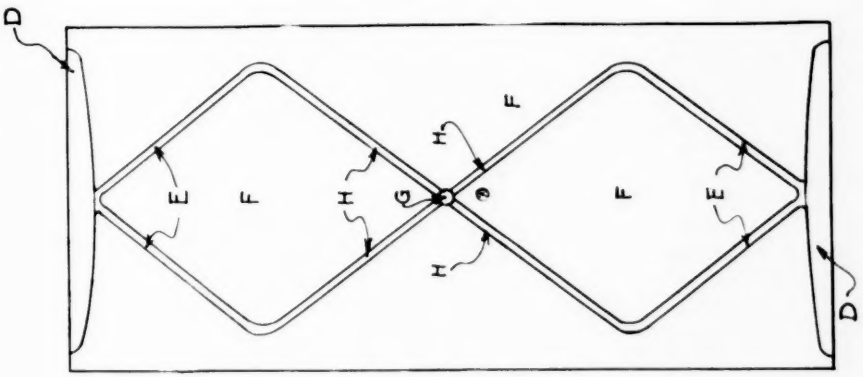
Figure 5 shows the oil grooving of the top and bottom shoes (or gibs) of a main cross-head of a horizontal engine which has the regular bored guides. There is no part of an engine more difficult to lubricate satisfactorily and economically than these bored guides, because the tendency is for the oil, in the case of the upper guide, to work down towards the lower edges, leaving the top or central portion of the guide dry; and in the case of the lower guide the tendency is for the oil to remain in the central portion of the guide, leaving the upper edges or sides dry. The effect of well designed oil grooves on the distribution of oil over surfaces can be noted better on such guides than on any other part of an engine, and a study of the grooves shown in Figures 5 and 6 and a close observation of the performance of their functions in actual operation will reveal more of what oil grooves do and how they do it than anything else we can suggest.

The plan view shows the bearing surface of the top shoe. Since the



Plan of Top Shoe





Inverted Plan of Bottom Shoe
Fig. 5
Showing Oil Grooves in Main Cross-Head

tendency in the case of the upper guide is for the oil to work down towards one or both of the lower edges of the guide, or be thrown off from the guide entirely, the chamfers A,A are made almost the entire width of the shoe at both ends of same and the grooves B,B, start from the ends of the chamfer. In operation, as the shoe advances the oil works along the chamfered edge until it reaches the grooves B,B which it enters, and following them is worked back up to the center or highest portion of the guide, also distributing the oil from the grooves over the surfaces C,C, while in motion.

The inverted plan shows the bottom shoe. In the case of the lower guide the tendency is for the oil to work down towards and lie in the center or lower portion of the guide and be thrown out at the ends of the guide. The chamfers D,D are therefore made to converge towards the center of the shoe, from which point the grooves E,E start and extend to points near the sides. In operation, as the shoe advances the oil works along the chamfer to the center or lowest point, where it enters the grooves E,E, and following them is worked back up to points near both sides of the guide, also being distributed from the grooves over the surfaces F,F.

In properly designed cross-heads an oil pocket is formed on the upper side of the bottom shoe to catch the oil which drips from the cross-head pin boxes, and an oil hole G is drilled through the shoe so that oil caught in the oil pocket is fed to the guide through the shoe. This oil hole G communicates with the grooves H,H, which work the oil up to the sides of the lower guide in the same manner that grooves E,E do.

In some engines the "pumping" effect of these grooves in the bottom shoe is so extreme as to result in displacing the oil from the center of the guide too rapidly. In such cases (and it is advisable to do so in every case where feasible) oil troughs or grooves should be formed along the sides of the guide to catch the oil which spills over from the guide, and by means of holes or grooves return it again to the guide.

SPECIFICATIONS

The question of standardizing material for any manufacturing or engineering work is a perennial one. It includes the value of the material as shown under the conditions of use,—which value will vary as the methods improve—and also the limitations which should be placed upon a material in order to secure the proper efficiency. As the knowledge of materials and the uses to which these materials, and new materials as they come up, can be put, the question of standard is constantly changing and the ideas and specifications of a generation ago are discarded today.

Illustrations of this changing condition in the matter of standards and specifications for material involved in any class of work can be cited from a number of lines of manufacture and trade. The specifications which obtained twenty years ago for the manufacture of armor plate for naval vessels would be so obsolete as to be laughable to any well-informed steel engineer or chemist at the present time. The introduction of carbon, vanadium, phosphorus, aluminum and other metals into the manufacture of steel, has introduced so many conditions which were not understood a few years ago, that the requirements in specifications and standards for a number of lines of work have been altered entirely during this time. New discoveries which are occurring every day, new materials, the values of which are being constantly discovered, make it necessary to rewrite

the standards and alter the specifications to suit the new conditions, in order that these standards and specifications shall have some value in exacting the proper limitations from the manufacturer, and shall not be mere arbitrary limitations imposed on the material on account of precedent.

These statements are particularly true of the oil industry, where the tests that have been carried from the refiner to the general public represent the methods in vogue at the refinery for securing uniformity in manufacture, and are only useful in comparing oils made from the same crudes, or a mixture of crudes.

A number of years ago, when the oil business was confined to a small section of the country and practically every refiner worked the same class of crude oil, such tests had at least a comparative value. As, however, the production of oil spread over a number of states, bringing into use crudes having various general chemical and physical characteristics, the comparative value formerly contained in these tests was necessarily lost and they represent today, except in one or two instances, obsolete and arbitrary methods of specifying which do not agree with the present information as to the values of different oils for any purpose.

This is particularly the case with lubricating oils where the conditions of use vary from the most delicate machinery where exact movements are required to the heaviest of heavy duties where the pressure is unusually great and the variations of temperature and exposure are very severe.

Growing out of the refiner's use of these tests while the business was confined practically to the same class of crude oils, the following tests were found to operate upon a comparative basis in demonstrating some values:

Gravity
Flash
Fire
Cold
Viscosity
Color
Evaporation
Residue
Freedom from acid or alkali.

Since it is now possible to secure oils refined from crudes which vary considerably in their original chemical and physical characteristics, the old comparative value of these tests has been lost entirely and they are now about as expressive concerning efficient lubrication as the size of lumps of coal would be expressive of their heating value. One might just as readily specify iron to be blank in color, or buy Portland cement on the basis of its appearance.

As a matter of fact it is customary to buy iron upon the basis of tensile and compressive strength, elastic limit, etc., all tests which have a direct bearing upon the ability of the steel to withstand the strains of actual working conditions, but the foregoing tests for lubricating oil have practically no relation to the work to be done, and any consideration of their value in connection with that work is left out, apparently, presupposing that the maker of the specifications which call for these tests is acquainted already with the characteristics of all the oils manufactured and the uses to which they are best adapted, so that he can himself translate the results of the tests into practical requirements.

As a matter of fact, this information is not possessed by the average engineer, and in fact is hardly available outside of the oil refining industry itself.

Many years ago when lubricating oils were practically all made from Pennsylvania crudes, these tests would have a value as a means of comparing one oil with another for the same purpose. While the refiner, however, on account of the discovery of new crudes in different parts of the country has been able to avail himself of a

number of new materials, the tests have not been altered to meet this condition; they fail to take into account the new possibilities in the oil field and the progress which has been made possible by the use of new oils possessing different characteristics. In other words, on account of the change in the industry they have automatically become obsolete and cannot be depended upon to explain to the buyer the proper values required of lubricating oils.

Lubricating oils manufactured from each kind of crude possess certain characteristics carried into the lubricating oil from the nature of the original crude itself, which characteristics have no bearing upon the value of a particular lubricant in actual service. Until the consumer, therefore, has made actual tests of all lubricants made from all the different crudes, he is not in a position to specify any combination of the foregoing tests which will be of value in buying the oil best suited for his requirements.

It is necessary, therefore, in considering the value of a lubricating oil to examine rather what is required of the same under actual service conditions and consequently the character of oil which will best fulfil the purpose. These requirements may be briefly stated as follows:

1.—The oil should possess sufficient body to keep the bearing surfaces apart at the temperature at which these bearings run.

2.—It should possess such qualities as will reduce the friction to a minimum.

3.—The flash point should be sufficiently high to insure against the presence of volatile constituents.

4.—It should remain fluid at such low temperatures as will be met in service conditions.

5.—It should have no tendency to decompose or to form such deposits as will gum up the machine and increase the friction where the object is to decrease it.

6.—It should contain no ingredients which will corrode or pit the metal.

In examining the tests at present used to demonstrate the value of a lubricating oil and comparing these with the requirements above stated, we find that the gravity of an oil indicates its weight in proportion to its weight in water. To the well-informed oil man it has another value and that is as indicating the source of the oil or rather the crude from which it is made. There is no indication as to the value of an oil for lubricating purposes, and the same is true of the other tests which are usually made for the purpose of specifying an oil to be used for any particular proposition. In order to illustrate this point, let us take the usual specification in this regard as below applied to engine oil manufactured from different crudes showing the variation in the characteristics:

Gravity	19 to 31°
Flash	320 to 400°
Fire	370 to 350°
Cold	0 to 30°
Viscosity (on Sayboldt instrument) or higher at 100° F.	120 to 750°

Oil coming within this range of characteristics can be picked out which would be suitable for all classes of engines, and the question of the suitability of these oils would not depend on the particular gravity, fire or flash displayed by the oil. All these oils have a flash point high enough for any ordinary conditions and do not contain injurious substances likely to pit or corrode the bearing surfaces or to form harmful deposits. As the flash point is sufficiently high in any of these cases to insure safety, it

follows that the fire point is also within the practical limits required by the conditions of work.

Inasmuch as gravity, fire and flash tests have no bearing whatever on the lubricating value, the first three tests are disposed of entirely and there remain only the tests on viscosity and cold. It is necessary to determine how high a viscosity is required for the actual conditions of work and how low a cold test should be used under the temperature range to which the engine bearings, etc., would be exposed; their range, however, in these cases is so wide that a proper determination could only be made from actual tests conducted on the machines themselves, and not until such actual tests had been conducted would the consumer be in a position to rightly specify which would have any value whatsoever.

Even after the practical tests were conducted further difficulty would arise which would not be shown up by the laboratory tests made upon the oils in accordance with the specifications. Two oils answering to the same laboratory tests might show entirely different results in actual work due to difference in the methods of manufacture which would not be appreciable in a laboratory inspection, yet of these two oils, answering the same tests, one would lubricate and the other would not.

In Texaco lubricating oils it is possible for us to vary the viscosity of an oil from 100′ at 100° to 2000′ at the same temperature without materially changing any of the other characteristics. The oil manufacturer is naturally familiar with every detail relating to his particular products and is in a position to know from experience with a wide range of conditions what can be obtained from each oil that he manufactures. If the consumer, therefore, approaches the matter from the standpoint of requiring from the manufacturer practical results in efficiency and economy, instead of tying him down to laboratory specifications, the manufacturer will be able to give a customer the oils which are most efficient for his purpose and secure a great deal better economy than is possible under the system of laboratory specifications at present in use.

The variations in the different crude oils make it impossible for a manufacturer handling one crude to duplicate the laboratory tests of oils made from entirely different crudes. This fact, however, does not indicate that the oil from one crude is better for a particular purpose than the oil from any other crude. If the matter is put up to the manufacturer on the basis of results in a practical way, it is frequently possible for him to furnish an oil which is more efficient for the purpose than the one previously used by the consumer, even though the laboratory tests may be entirely different. It has been demonstrated in actual practice time and time again that neither the laboratory specifications upon an oil nor the price of an oil for any particular purpose has a bearing upon the efficiency of lubrication, except that, of course, a good quality of oil is always worth the price in economy of operation. The losses for which the consumer pays, due to friction in his machinery and all moving appliances, are very heavy, and the only method which will result in any saving of such losses is the method of the actual test on the machinery he employs.

Further, complication in the specifications for oil are due to the fact that these specifications are frequently based upon tests made with instruments not in common use and for which there are no means of translating the results into readings upon standard instruments. Tests of this kind are frequently impossible of reproduction, owing to the lack of information on the part of the maker of

the specifications. After a study of this subject for many years, it is our opinion that buyers of lubricating oil on specifications discriminate against themselves in limiting competition so that they are not securing the most efficient lubricant offered by the wide range on the market and at the same time losing opportunities for saving many times the cost of the oil by the reduction of friction losses. All of these things could be obviated if, instead of specifying certain laboratory tests, well-equipped manufacturers were asked to put in efficient oils suitable for certain mechanical conditions.

A Rag and a Few Drops of Gasoline

THIS is all the equipment that is required to remove any carbon that may be deposited in the cylinders of an engine using

Texaco Motor Oil

Those of you who have ever had the pleasure (?) of chipping away at an engine with a cold chisel and a hammer to remove carbon can appreciate the full meaning of this.

But Remember this:

Under ordinary circumstances Texaco Motor Oil will not deposit carbon. It is only when through the use of too much oil or for some such reason that the combustion is incomplete; that a slight amount of carbon is deposited. This deposit is of a soft spongy nature. It will not work in between the piston rings and cannot scratch or cut the cylinder walls.

This feature in itself is of considerable importance in the lubrication of Internal Combustion engines and when considered along with the excellent lubricating qualities and its zero cold test, Texaco Motor Oil becomes the logical choice of the man who desires efficiency and economy in lubrication of such engines.

Texaco Motor Oil maintains a film between moving parts that always holds the compression and prevents injurious metal to metal contact.

Along with our Motor Oil, we recommend the use of

Texaco Transmission Grease

as an aid to securing the highest type of motor lubrication.

Look for the green can with the lucky red star and lubricating efficiency and economy are yours.

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